Space Weather Technical Forecast

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

Issued on Tuesday, 10 September 2024 at 13:09 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Ongoing S1. R1-R2 Likely. G1-G2 Likely Tuesday 10 into Wednesday 11 September.

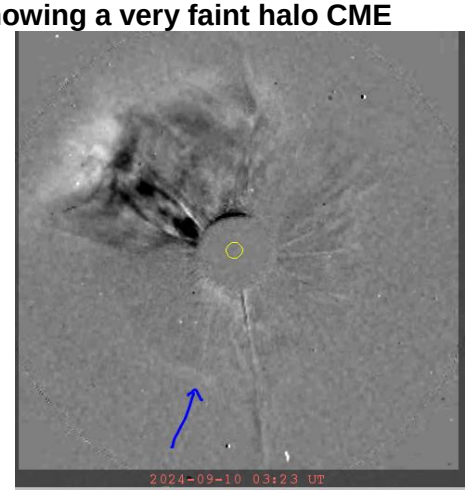
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity as measured by GOES16 and 18 has been Moderate, with an impulsive M3.4 observed at 09/1708 UTC from AR3814 in the northeast quadrant.

There are currently nine sunspot regions on the visible disc, most of which are on the western hemisphere. These are relatively simple, except for AR3811 and AR3816. The largest and most complex region is AR3814, now approaching the north central meridian. It consists of a large spot with penumbra preceded by a developing spot with penumbra and several little specs waxing and waning in-between. Immediately east of this region is AR3822, undergoing significant growth in the last 24 hours.

An asymmetric CME was observed on Coronagraph imagery during the early UTC hours of the 10th, following the long-period M1.2 from AR3814. While the bulk of the ejecta is expected to pass north of Earth, a very faint halo was detected. Preliminary analysis estimated it at 426 km/s, giving an arrival at Earth slightly after the end of Day 4. However, confidence is low.

Figure 0: Stereo-A image showing a very faint halo CME



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Solar Wind / Geomagnetic Activity: The solar wind measured by ACE at L1 showed a possible stepped entry into a fast wind of unknown provenance. The phi angle has been largely negative (towards the Sun), which precludes any contribution from CH65/+. The solar wind speed was mostly around 400-450 km/s. The solar wind density was erratic but small-magnitude within typical single-figures ppcc throughout. The IMF was moderate initially, briefly peaking at 13nT at around 09/1300 UTC before slowly decreasing, while the north-south component varied between +8 and -6nT, with an overall co-aligned bias to help limit geomagnetic activity.
The net result of the above solar wind measures was for a Quiet geomagnetic activity with one Unsettled interval.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 showed a gradual decreasing trend, eventually returning below the S1 / Minor Storm level at around 10/0750 UTC. Flux levels peaked at 44.9 pfu at around 09/2305 UTC. 50 and 100MeV protons showed no notable response.

High energy electron flux (greater than 2MeV) observed by GOES16 was at Normal Background levels. The associated 24-hour fluence remained below the Active threshold, with 1.29e6 integrated pfu observed at 09/2359UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely to continue throughout, with a daily Slight Chance of X-class flares. The complexity and flare risk of oncoming sunspot regions is likely to exceed that from any departures through midweek UTC, and the overall risk is upwards around this time.

Solar Wind / Geomagnetic Activity: No significant fast winds feature in the forecast, and the main driver of geomagnetism in the period is therefore any glance from the 08 September filament CME. This is most likely due later in the UTC day of Tuesday 10 September into Wednesday 11 September with a Chance of G1-G2 Minor to Moderate geomagnetic storm. Another Earth-directed CME is possible but is considered to be outside this time frame.

Energetic Particles / Solar Radiation: A heightened risk of flare activity brings a daily chance of reaching/exceeding the S1 Minor Radiation storm level, should any significant flares occur from active regions in the western hemisphere. High energy electron flux is expected to remain near current Normal Background levels throughout, with Active 24-hour fluence not expected.

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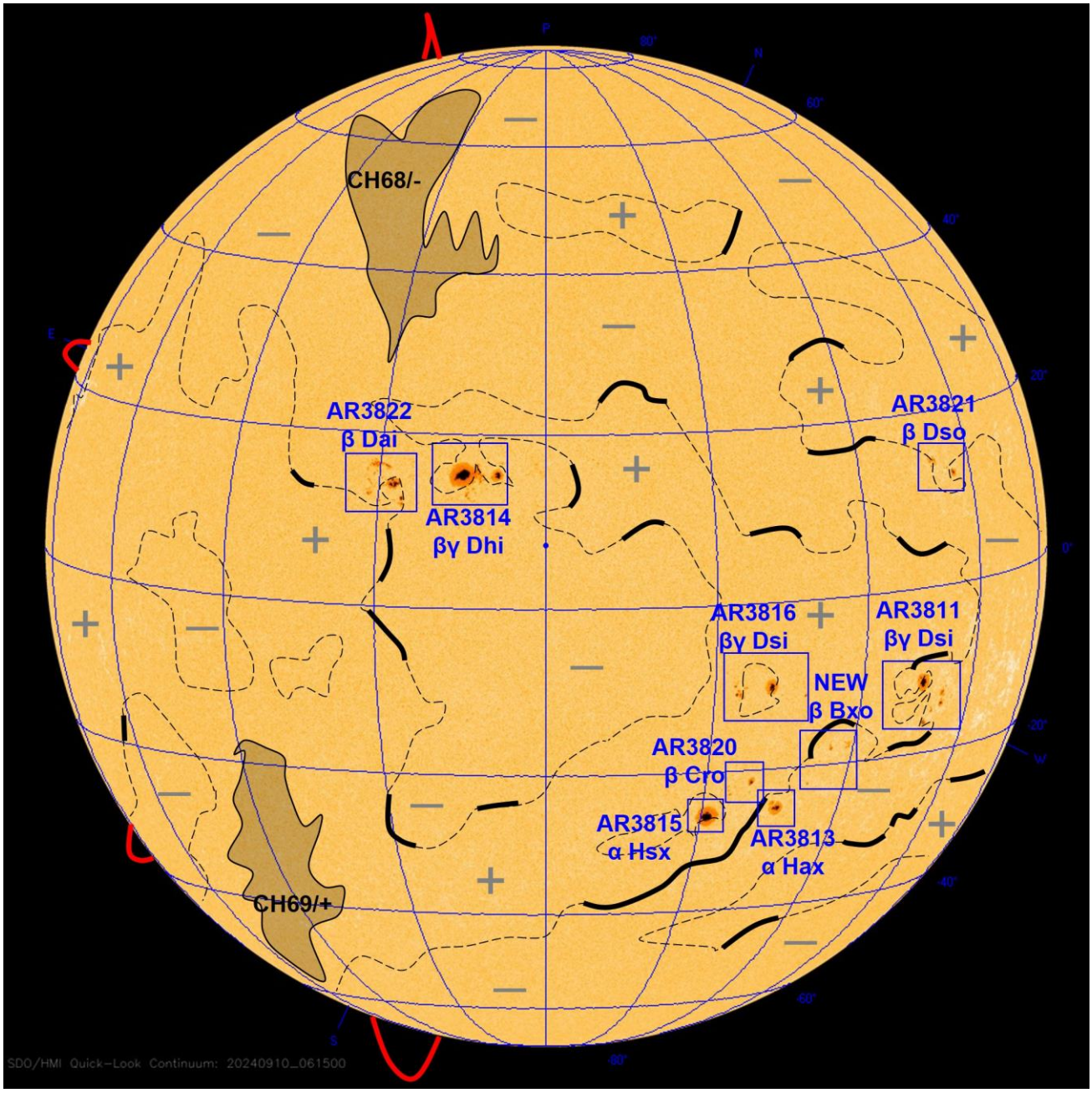
Figure 1. Solar Analysis Valid 10/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

This four-day forecast period comprises minor fast wind influence to start, with one glancing CME due between Tuesday 10 and Wednesday 11 September.

The current minor fast wind does not have a clearly identified source on the disc (being of the wrong polarity to have originated from CH65/+), however has probably peaked at Unsettled geomagnetic intervals. This current fast wind is soon expected to fade. CH68/- is a high solar latitude persistent coronal hole, however this has retrogressed by around a day (13 degrees) on this rotation, which would very likely put any minor 450km/s fast wind into the coming UTC weekend rather than the end of the UTC working week (i.e. outside the forecast period). No significant coronal holes are therefore expected in the forecast.

The sole CME in the forecast arose from the filament eruption that occurred early on 08 September, and is likely to give Earth some glancing influence, either late on Day one, Tuesday 10 September, or early on Day 2 - Wednesday 11 September. This being said, the bulk of its ejecta is expected to pass ahead of Earth's orbit.

There is, on balance, considered a Chance of a period of G1-G2/Minor-Moderate Storm from the inbound CME, with no other significant contributions to the geomagnetic forecast from fast winds. Because the CME is a glancing blow this is represented in the probability tables as a relatively broad and flat peak risk, perhaps slightly more likely to peak on Wednesday 11 September in any ensuing magnetic cloud before waning into the later half of the week.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	40	10	1
Strong	G3	No	5	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/0525 UTC	Partial	Filament	NW	700 km/s	11/0000 UTC +/- 12h	Glancing blow likely

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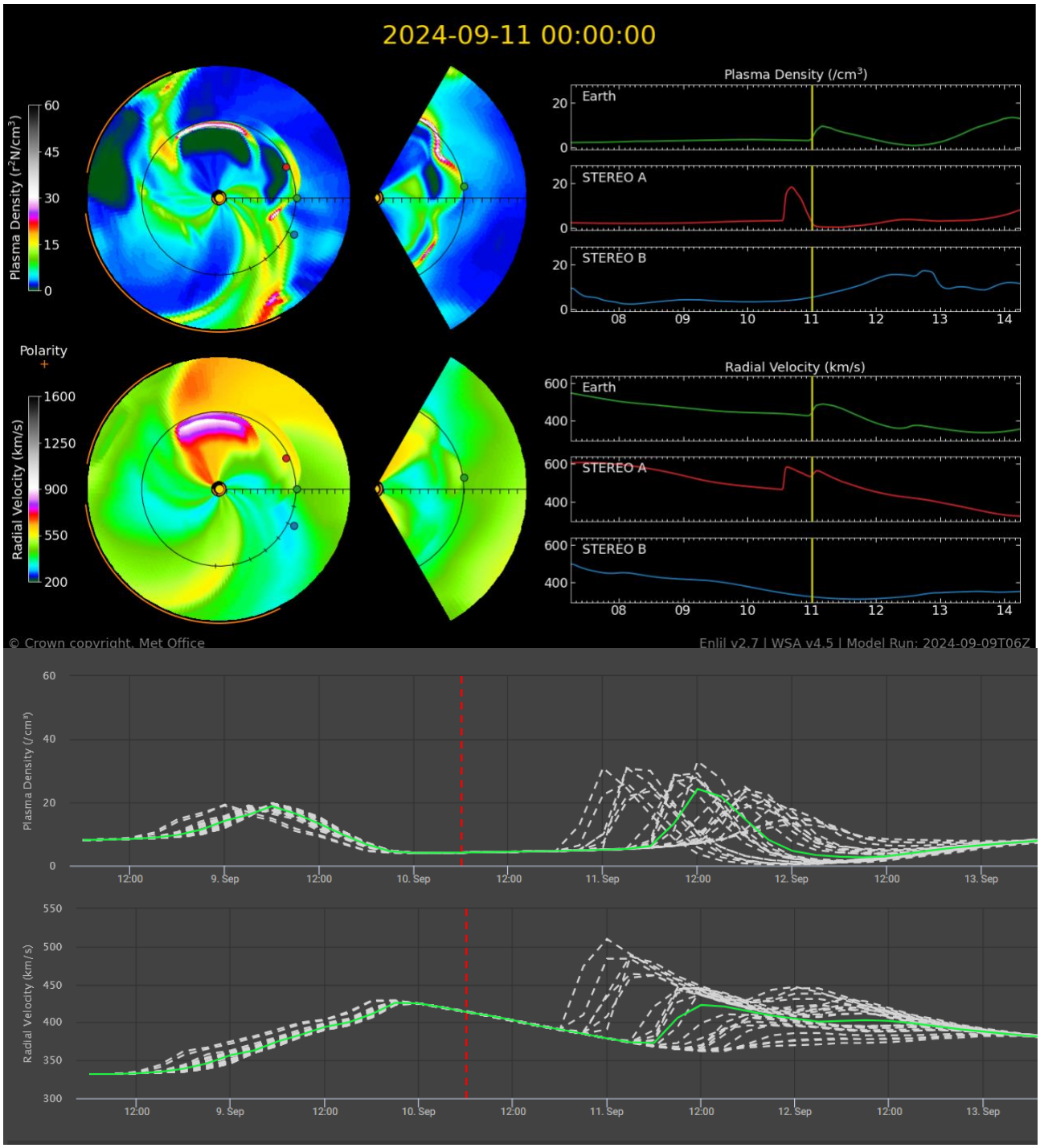
Figure 2: MOSWOC Enlil and Ensemble models showing possible CME arrival time



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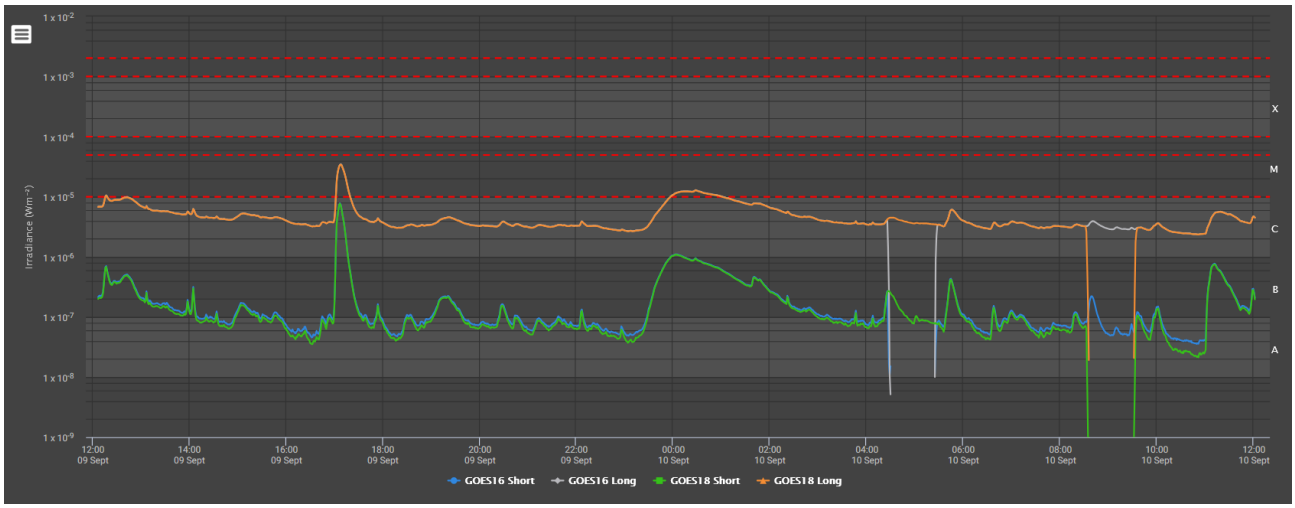
Radio Blackouts - X-Ray Flares:
There are currently nine sunspot regions on the visible disc, most of which are on the western hemisphere. These are relatively simple, except for AR3811 and AR3816. The largest and most complex region is AR3814, now approaching the north central meridian. It consists of a large spot with penumbra preceded by a developing spot with penumbra and several little specs waxing and waning in-between. Immediately east of this region is AR3822, undergoing significant growth in the last 24 hours.

The imminently arriving eastern solar horizon encompasses several large returning regions including Ex-AR3790, 92, 93 and 3802, i.e. those roughly between Carrington Longitudes 020 and 035. One of the northern hemisphere regions, perhaps 3802 was responsible for a large and energetic CME in the past 24 hours off the eastern limb, and was perhaps also responsible for noteworthy far-sided CMEs on 03 and 05 September. As well as this northern hemisphere feature, there appears to be a magnetic connection to the southern hemisphere cluster (in e.g. AIA171 imagery), and this part of the Sun returning to the facing side of the disc is therefore very likely to result in an upturn in daily flare risk.

With Ex-AR3806 rotating off the disc, there are no more departures expected until AR3811 and AR3821 follow suit by day four, Friday 13 September. Given the likely complex arrivals due by midweek UTC, the overall risk of significant flares is upwards in the period, with M class Likely and a Slight Chance of X-class.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	70	70	70
Very Active	R3 to R5 X Class	No	10	15	15	15

Figure 3: Latest X-Ray flare activity, as observed at GOES-16 and GOES-18



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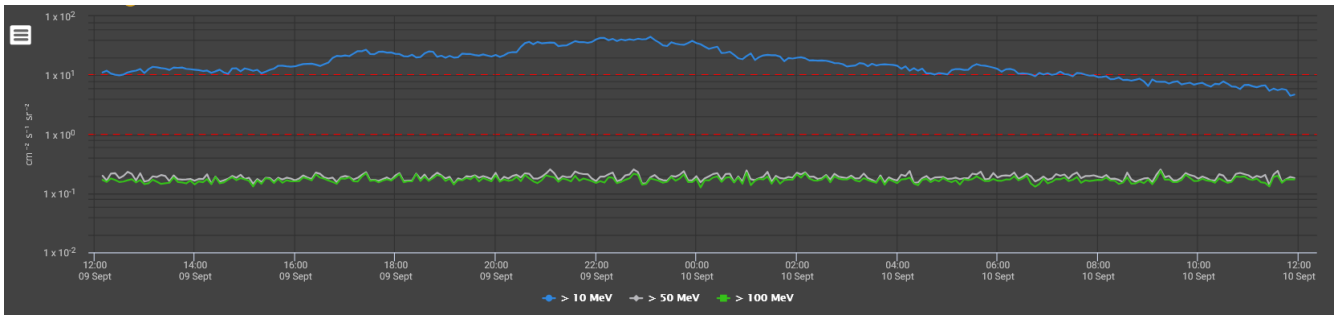
Solar Radiation Storms - (High Energy Protons):
High energy proton flux showed a gradual decreasing trend, eventually returning below the S1 / Minor Storm level around 10/0750 UTC after the enhancement prompted by the long-period 09/0333UTC M1.0 from Ex-AR3808. The flux is currently levelling off just below the S1 level and is expected to remain at this level over the next 24 hours.

Further chance of reaching the S1 Minor Radiation Storm threshold in the coming days, if any other significant flaring occurs from the cluster of active regions currently transiting across the southwest quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	30	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: High Energy Proton Flux, as observed at GOES-18



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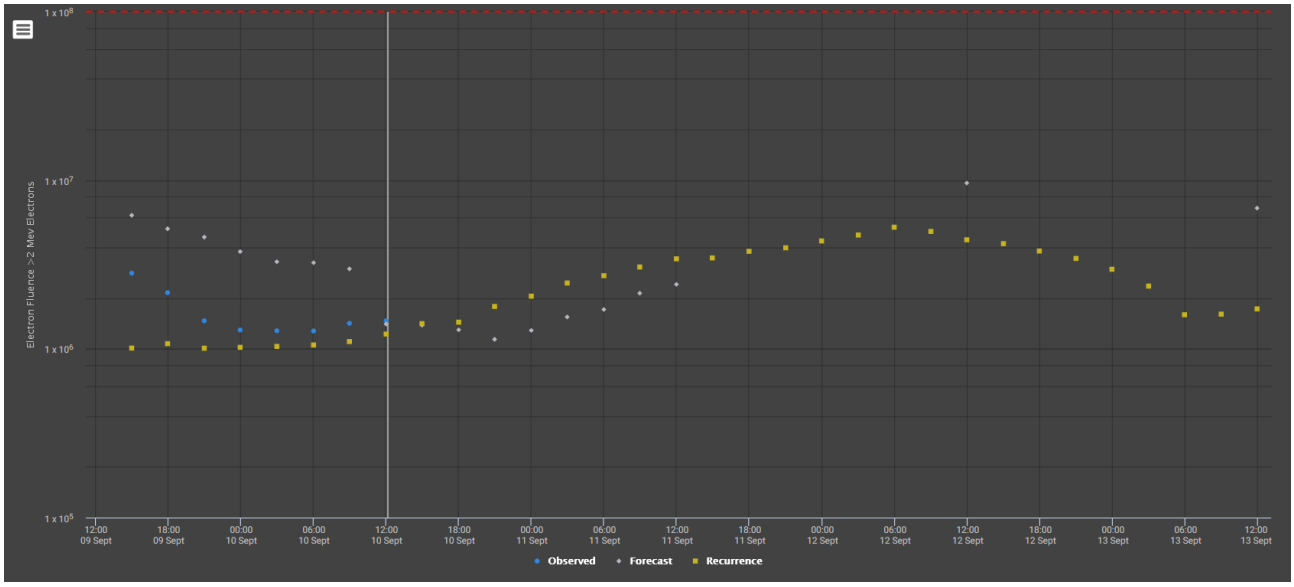
High Energy Electrons Event (≥ 2MeV):

The diurnal oscillation of high energy electron flux has been within the confines of Normal Background levels in the past 24 hours. While Earth may now have connected with a minor fast wind, the fact that this appears to have now peaked should mean there is little likelihood of Active 24-hour fluence resulting, especially since the 08 September CME is perhaps due at a time when any recovery of the Van Allen belts to encompass GEO might be expected.

All considered, the chances of Active 24-hour fluence are very low throughout.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: Latest Met Office REFM output



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